Military Training Task Force
Joint Services Physical Training Injury Prevention Work Group

Recommended Interventions and Program Elements To Reduce Physical Training-Related Injuries

RECOMMENDATION 1

Prevent overtraining by de-emphasizing distance running during physical training.

Overtraining (caused largely by excessive distance running) results in higher injury rates, lowered physical performance, decreased motivation, and increased fatigue and attrition. The Joint Services Physical Training Injury Prevention Work Group (JSPTIPWG) found strong evidence that physical training programs, especially in initial military training, that reduce distance running miles and incorporate the following related six elements prevent overtraining and reduce injury rates while maintaining or improving physical fitness:

(1) Commanders at all levels should actively avoid combinations of physical and military training that exceed physiologic thresholds of overtraining that result in higher injury rates and do not improve fitness. Commanders can monitor profile (limited duty excusals) rates and fitness test pass rates and run times to determine if their units are overtraining. Signs that a unit is overtraining include high or increasing lower body injury profile rates, decreased fitness test pass rates, and slower average run times. Other ways to achieve this objective include the following recommendations.

(2) Follow a standardized, gradual, systematic progression of running distance and speed beginning with lower mileage and intensity, especially for those just starting a physical training program (e.g., new recruits, changing units, or returning to PT after time off for an injury or leave).

(3) Structure physical training injury prevention programs to target those servicemembers at the highest risk of injury (those of average or below average fitness) by ensuring that the running mileage for the least fit servicemembers is appropriate for their fitness level.
   a. Use fitness test performance (run times) to place servicemembers in ability groups of similar fitness levels that provide each servicemember with a more appropriate level of physiological stimulus to enhance fitness and minimize injury risk. (Running by time, not distance, allows the least fit to run shorter distances than the most fit, thus accommodating low and high fitness groups simultaneously).
   b. Avoid remedial physical training programs that require the least fit servicemembers, especially recruits, to do more training than fit servicemembers since it significantly increases risk of overtraining and injury with little or no fitness improvement.

(Gradual, progressive ability group training programs improve fitness with less risk of overtraining and injury.)

c. Limit formation running as it overtrains the least fit and provides an inadequate training effect for the most fit.

(4) Replace some distance runs with higher intensity, shorter distance runs (e.g., interval training activities like repeated sprints, Fartlek training, and last-man-up, etc.) that increase speed and stamina more rapidly than distance running while limiting total miles run.

(5) Balance the body's need for a physiologic training overload with the need for recovery and rebuilding by coordinating military and physical training to:

a. Avoid exhaustive military or physical training (e.g., obstacle courses, long road marches with heavy loads, longer runs, maximal-effort physical fitness testing, etc.) on the same or successive days.
b. Allow adequate recovery time between administrations of maximal effort physical fitness tests (ideally 3-5 days for servicemembers in operational units) to prevent overtraining and increase the likelihood of improved physical performance.
c. Alternate training days that emphasize lower body weight-bearing physical activity with training days focused on upper body conditioning.
d. Minimize the accumulated weight-bearing stress on the lower body from marching/hiking, movements to training sites, drill and ceremony, obstacle courses, running, etc., by not over scheduling such activities on the same or successive days.

(6) Perform lower intensity, task-specific, dynamic activities to warm-up prior to more intense physical training (e.g., walking and slow jogging in preparation for running). Since the scientific evidence is clear that pre-exercise stretching is not protective against injuries, one should not expect stretching exercises during warm-up to prevent physical training-related injuries.

Rationale

Military research has demonstrated that during initial military training about 25 percent of men and about 50 percent of women incur one or more physical training-related injuries. About 80 percent of these injuries are in the lower extremities and are of the overuse type—a condition brought about by physical training volume overload (generally excessive running). Both civilian and military research shows that increasing running mileage increases the incidence of musculoskeletal injuries.

A landmark physical training study demonstrates that there are thresholds of exercise above which increases in running duration and frequency dramatically increase risk of injury with little improvement on estimated 2-mile run times or maximal oxygen uptake (a measure of cardiovascular endurance that correlates with run-time performance). This study examined the effects of increasing duration and frequency of running on injury risks and run performance among previously sedentary young adult males.

Table 1 illustrates that running duration of 45 minutes versus 30 minutes increases the injury incidence (percent of subjects injured) by 125% (over 2 times) with only a 5% increase in maximal oxygen uptake (equivalent of an estimated 18 seconds faster on a 2-mile run).

Table 2 indicates that a running frequency of 5 times per week versus 3 times per week increases the injury incidence by 225% (over 3 times) with only a 35% increase in maximal oxygen uptake (equivalent of an estimated 36 seconds faster on a 2-mile run). This study shows that there are physiological thresholds above which increases in exercise duration and frequency do not result in a commensurate increase in fitness, but *do* result in higher injury rates (particularly for people with average and below average fitness levels). The bottom line is that the amount of running can be dramatically reduced to prevent injuries without decreasing fitness levels.

Table 1. Running **duration**, injuries, and cardiovascular endurance.*

Duration (min/day)	Injury Incidence (percent)	Change in CV Endurance (percent maximal oxygen uptake)	Estimated Change in 2-Mile Run Time (minutes)
0	0	-.7	- :06
15	22	8.7	1:12
30	24	16.1	2:00
45	54	16.9	2:18
From 30 to 45 min/day	125% increase	5% greater	:18 faster

*Training: running 3 days/week, 85-90% MHR.

Table 2. Running **frequency**, injuries, and cardiovascular endurance.*

Frequency (days/week)	Injury Incidence (percent)	Change in CV Endurance (percent maximal oxygen uptake)	Estimated Change in 2-Mile Run Time (minutes)
0	0	-3.4	- :30
1	0	8.3	1:06
3	12	12.9	1:48
5	39	17.4	2:24
From 3 to 5 days/wk	225% increase	35% greater	:36 faster

*Training: running 30 min, 85-90% MHR.

Military research also shows that the gradual introduction of running and the reduction of running mileage reduces injury incidence. A program that de-emphasizes distance runs but which systematically and progressively increases running mileage to a maintenance point reduces injury rates and fosters just as much improvement in physical fitness. The research is clear that performing LESS distance running does NOT adversely affect servicemember scores on standard Service-specific cardiorespiratory fitness testing while reducing injuries.

Interval training is one of the best methods of reducing total running mileage while most efficiently increasing cardiovascular fitness. From a performance perspective, substantial evidence exists that interval training results in more rapid improvements in running speed and endurance than long-slow sustained running, and these improvements are achieved with many

fewer total miles run. Military studies that have included interval training with reduced total running mileage have shown fitness improvements as great as or greater than those with long-slow sustained running.

Least fit servicemembers are two to three times more likely to be injured as their more fit counterparts, especially in the recruit training environment. In order to reduce injuries and attrition rates while maximizing physical performance requires that the core of any physical training program be targeted directly at these servicemembers of average and below average fitness levels. Servicemembers of below average fitness who overreach their physical capability have an increased risk of overtraining characterized by increased injuries, fatigue and depression and decreased motivation and physical performance.

RECOMMENDATION 2

Increase exercises to improve body movement skills during physical training.

The JSPTIPWG found good evidence that increasing the proportion of physical training time devoted to improvement of body movement skills reduces injuries. These body movement skills include agility, posture, stability, flexibility, balance, speed, power, reactive ability, and coordination. Focus must be on improving precision of movement during execution of these exercises.

Rationale

Including more body movement skills training and more strength and agility conditioning in physical training sessions reduces injury risk for several key reasons: (1) incorporating these activities into a finite training period reduces the trainees' excessive exposure to running activities, thereby reducing lower body injury risk; (2) musculoskeletal stresses of training are more evenly distributed across the body by these type drills (unlike running, which focuses stress narrowly in the lower body), thereby reducing injury risk; and (3) strength and stabilization exercises directed at the body core (trunk) represent many of the same movements required during more complex combat activities and thereby increase the likelihood of improved military occupational task performance. Physical training should balance cardiovascular stamina with strength and agility by providing strength and agility conditioning on alternate days from cardiovascular training (i.e., running, marching/hiking, etc.). Varying conditioning is a standard training technique in the athletic world that permits more conditioning activity without overtraining one particular muscle group or system. Some examples where this kind of balanced training has proven successful in the military are Physical Readiness Training for Army initial entry training and the Marine Corps Recruit Training Program. Consistent adherence to the standardized approach to body movement skills physical training will maximize PT time and develop the optimal combination of strength, coordination, agility, power, and stamina in warfighters.

RECOMMENDATION 3

Provide mouthguards for all individuals participating in high-risk activities.

The JSPTIPWG found good evidence that mouthguards reduce orofacial injuries when worn during activities with high orofacial injury risk (e.g., combatives, obstacle courses, rifle/bayonet training, etc., and contact sports such as basketball, football, etc.).

Rationale

Army Training and Doctrine Command posts where trainees wear mouthguards have reduced orofacial injuries by 68 percent. Also, civilian studies show that mouthguards result in large reductions in dental injuries in specific sports (e.g., football, rugby, basketball, and ice hockey). The Army has made mouthguard use a requirement by incorporating this intervention in AR 600-63; Army Health Promotion Program: "The Army Unit commanders will require and enforce mouthguard use during pugil stick training, bayonet/M16 training, obstacle/confidence course training, and hand-to-hand combat training. Commanders will require mouthguard use during PT or Unit sports activities that may involve injury to the face or mouth as a result of head-to-head contact, falls, tooth clenching or blows to the mouth."

The Army Center for Health Promotion and Preventive Medicine has designed a program review and Mouthguard Implementation Toolkit to facilitate implementation of this recommendation (see http://chppm-www.apgea.army.mil/dhpw/Wellness/mouthguard.aspx).

RECOMMENDATION 4

Make semi-rigid ankle braces available for use by individuals at high risk for re-injury (i.e., those with history of previous ankle sprains) and for others during high-risk activities.

The JSPTIPWG found strong evidence that semi-rigid ankle braces reduce re-injuries for individuals with previous moderate or severe ankle sprains and good evidence that semi-rigid ankle braces reduce ankle injuries when participating in high-risk physical activity such as airborne operations (parachuting), obstacle courses, basketball, volleyball, soccer, etc.

Rationale

One of the most significant risk factors for sustaining a new ankle sprain injury of any grade is a previous sprain of the same ankle. In other words, once one has sustained an ankle sprain injury, the risks of re-injury to that same ankle are extremely high regardless of the mechanism of the initial injury (e.g., sports, parachuting, stepping in a hole, etc.). This can be due to a loss of muscle and/or ligament strength, proprioception (joint position sense), muscle reaction time or, most likely, all of the above. Individuals with a past history of moderate to severe ankle sprain should wear ankle braces during activities where ankle injuries are likely (e.g., sports, obstacle courses, parachuting, etc.). Sufficient evidence exists to recommend semi-rigid ankle stirrup braces that allow plantarflexion and dorsiflexion (up and down) but limit inversion and eversion

(turning the foot/ankle complex in and out) for others when engaged in activities where the risk of inverting or everting the ankle beyond its normal limits is high. Generally, these activities include training or landing on uneven or unpredictable surfaces (e.g., rugged terrain, night ground operations, movement through heavy undergrowth, airborne operations, etc.) and sports or sport-like activities that require sudden changes in direction and that may involve collision or contact with opponents' feet or a ball (e.g., obstacle course, basketball, volleyball, soccer, etc.).

RECOMMENDATION 5

Provide nutritional supplementation (protein/carbohydrate snack and electrolyte fluids) within one hour after strenuous, prolonged, continuous physical activity of greater than one hour.

The JSPTIPWG found sufficient evidence that supplementation of a carbohydrate-protein snack and balanced fluid replacement beverage within one hour after very strenuous, prolonged, continuous physical activity (e.g., prolonged road marching/hiking) reduces injury. Collateral benefits such as reduction of heat-related illness and enhanced physical performance can be expected.

Rationale

Research indicates that restoring energy balance and adequate muscle glycogen (carbohydrate stores in the muscle) decreases markers of muscle damage due to physical activity. Sustained physical activity and intermittent high intensity activity deplete the body's glycogen stores and fatigue muscles, which then reduce their strength and ability to protect joints. Research shows a link between muscle glycogen depletion and markers of muscle damage, fatigue and musculoskeletal pain. Studies of active women also indicate a negative energy balance is a risk factor for stress fractures of the bone.

Both civilian and military research have provided evidence that nutritional supplementation overcomes fatigue, minimizes muscle damage, and protects against heat injury. However, the timing of the nutritional intervention is critical. Specifically, research indicates that providing a combination of carbohydrates and protein within a 60-minute window immediately following very strenuous exercise initiates repair of muscles damaged during the activity and begins the replenishment of muscle glycogen stores. During this time, metabolic environment is optimized for rebuilding what was used or broken down during the exercise. If the nutrients are not provided until more than one hour afterwards, the metabolic environment is less well prepared to absorb the nutrients; thus minimizing recovery.

The ideal amount of nutritional supplementation needed to allow for the most rapid replenishment of muscle glycogen to protect against muscle damage and accelerate the recovery process is roughly 50 to 75 grams of carbohydrate and 12 to 18 grams of protein (1 gram of protein for every 4 grams of carbohydrate).

ESSENTIAL PROGRAM ELEMENTS

Injury Prevention Education

The JSPTIPWG strongly recommends injury prevention education for all levels of leadership whether as a part of institutionalized continuing military education or web-based distance learning programs. The reduction of injuries is most likely to occur if all levels of leadership (command and cadre) understand how servicemembers are injured and which interventions work to prevent them. Education is the first step in disseminating evidence-based interventions that can be implemented at the unit level and is the first component of any successful program that reduces injuries.

Leadership Enforcement

The JSPTIPWG strongly recommends military and civilian leadership enforcement of injury prevention policies and programs at all levels. The success of any program is directly related to the level of visible command support and involvement. The unit commander is the critical agent for injury prevention intervention. Effective command emphasis on injury prevention must be consistent, lasting, and based on evidence-based interventions and common sense to reduce exposure to injury risk during physical training, field exercises, and off-duty recreational activities.

Surveillance

The JSPTIPWG strongly recommends the Military Training Task Force (MTTF) support mandatory injury cause coding and automated physical profiling (documented nature of limited duty severity) in the outpatient electronic health record. To systematically analyze and prevent injuries throughout the DoD, routine medical surveillance of injury causes and severity is critical. Currently, cause coding for injury hospitalizations is fairly complete. However, the vast majority of injuries and injury-related musculoskeletal conditions (over 1.9 million annually across DoD resulting in an estimated 25 million days of limited duty) are treated on an outpatient basis, which is why it is so important to capture cause and severity data. (Severity and direct impact on physical readiness can be tracked and reported through the use of an automated physical profile which captures the number of days lost to ‘sick in quarters,’ the number of days of limited duty, and the degree of physical limitations due to injury.) The current and emerging electronic health record (Composite Health Care System and AHLTA) do not enforce the guidelines for recording and coding injury causation and severity (physical profiling) in the outpatient record. Additionally, department wide surveillance of physical fitness would also provide rich information since it is one of the primary risk factors for injury. Data on injury cause and severity, as well as physical fitness, would greatly facilitate the prioritization of resources, research, and the targeting of interventions to reduce injury rates, thereby improving physical readiness.

Research and Program Evaluation

The JSPTIPWG strongly recommends a greater investment of resources (DoD wide) to investigate promising interventions to reduce injuries. The sparse number of interventions that had enough scientific evidence to evaluate effectiveness for the leading health problem impacting on U.S. military force readiness today is a testament to the need for more research and program evaluation in this area of musculoskeletal injury prevention.

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Scientific references for these recommendations are available upon request.